Polytechnic Tutoring Center

Final Exam REVIEW – CM 1024, Spring 2020

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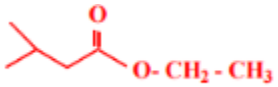
ANSWER KEY

1. 3-methylbutanoic acid + ethanol → ethyl 3 methylbutanoate



By product is water

2. a) ester b) amine c) alkene d) aldehyde e) ether f) ketone
3. a) 2O 3 ↔ 3O 2 b)O* c) None d) ra = ka ($[O_3]^2$ -$[O_2]^3$/ Kc)
4. a) ~30 katm liquid → solid (graphite)
   ~100 katm solid (graphite) → liquid
   b) P < 30 katm sink
   P > 100 katm Float
   c) T ~ 4500K
5.

	ion-ion	dipole-dipole	London (or dispersion) forces	hydrogen bonding	Highest b.p.: a) or b), and why ?
1 a) HF (g)		x	x	x	HF, H bonding
1 b) HCl (g)		x	x		
2 a) H_2S (l)		x	x		H_2Se, higher MW
2 b) H_2Se (l)		x	x		
3a)CH_3CH_2OH(l) (ethanol)		x	x	x	ethanol, H bonding
3b) CH_3OCH_3(l) (dimethyl ether)		x	x		

6.

1st Soln $[H^+] = 10^{-pH} = 10^{-2}$ M
10.0 mL / 1000 = 0.0100 L
$(10^{-2}$ M) (0.0100 L) = $1.00*10^{-4}$ mol H^+

2nd Soln $H^+] = 10^{-pH} = 10^{-6}$ M
10.0 mL / 1000 = 0.0100 L
$(10^{-6}$ M) (0.0100 L) = $1.00*10^{-8}$ mol H^+

Combined Soln 0.0100 L + 0.0100 L = 0.0200 L
$1.00*10^{-4}$ mol + $1.00*10^{-8}$ mol = $1.00*10^{-4}$ mol
$1.00*10^{-4}$ mol / 0.0200 L = $5.00*10^{-3}$ M
pH = -log$[H^+]$ = -log($5.00*10^{-3}$ M) = **2.30**

7. Kc = (3.36 * 0.08206 * 500) = 137.9

Eqn 2x(-1/2)	$NO + ½ O_2 \rightarrow NO_2$	$K_2=(5.9 \times 10^{-5})^{-1/2}$
Eqn 1x(-1/2)	$NO_2 \rightarrow ½ N_2O_4$	$K_1= (1.5 \times 10^{3})^{-1/2}$
	$NO + ½ O_2 \rightarrow ½ N_2O_4$	$K= K_1 K_2$

$K_p = K_1 K_2 = 130.19 \times 0.02582 = 3.36$

$K_p=K_c (RT)^{\Delta n}$

$\Delta n = (½) - (1 + ½) = -1$

8. $Kc = [NO]^2[Cl2] / [NOCl]^2$

	NOCl	NO	Cl_2
I	1.67M	-	-
C	-0.28*1.67M	+0.28*1.67M	-0.14*1.67M
E	1.20M	0.467M	0.233M

K_c = **0.0353**

9.

	$NH_3(aq)$ + H_2O (l) →	NH_4^+ (aq) +	$OH^-(aq)$
Initial (M):	0.50	0.0	0.0
Change (M):	-x	+x	+x
Equilibrium (M):	0.50 – x	x	x

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$ $1.8 \times 10^{-5} = \frac{x^2}{0.50\text{-}x} \approx \frac{x^2}{0.50}$ $\frac{3.0 \times 10^{-3}\text{M}}{0.50\text{ M}} \times 100\% = 0.60\%$

$x^2 = 9.0 \times 10^{-6}$

$x = 3.0 \times 10^{-3}$

$[OH^-] = 3.0 \times 10^{-3}$ M

pOH = - log (3.0×10^{-3}) = 2.52

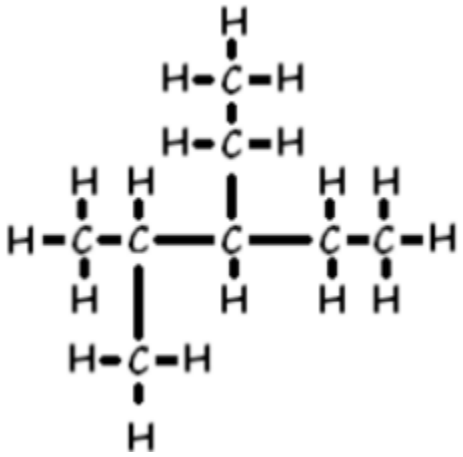
pH = 14 – 2.52

pH = 11.48

10.

a. $\Delta G^o = -RT\ln K = -(8.314\ J/mol\ K)(298\ K)\ln(0.113) = -(8.314\ J/mol\ K)(298\ K)(-2.180)$
$\Delta G^o = +5401\ J/mol = +\mathbf{5.40\ kJ/mol}$
b.
$\Delta G = \Delta G^o + RT \ln Q$
$Q = P^2_{NO2} / P_{N2O4} = 0.122^2 / 0.453 = 0.0328$
$\Delta G = +5401\ J/mol + (8.314\ J/mol\ K)(298\ K)\ \ln(0.0329) = (+5401 - 8462)\ J/mol$
$\Delta G = -3060\ J/mol = \mathbf{-3.06\ kJ/mol}$
d. (-), Spontaneous, goes left to right, toward products

11. a) Rate= k [CH3COCH3][Br 2]
    b) 0.0038 / M. s
12. Achiral, no chiral carbons and is a superimposable mirror image



13. T = toluene and B = benzene Assume 200 g total, 100 g each
    100.0 g x (mol / 78.11 g) = 1.280 mol benzene
    100.0 g x (mol / 92.14 g) = 1.085 mol toluene
    total # moles = 2.365
    benzene XB = 1.280 / 2.365 = **0.5412** toluene XT = 1.085 / 2.365 = **0.4588**
    Ptotal = PT + PB Ptotal = XTPT* + XBPB* = (0.4588) (29.1 torr) + (0.5412) (94.6 torr) Ptotal= 51.20 + 13.35 = 64.55 = **64.6 torr**
14. $[A] = [A]_o\ e^{-kt}$ $0.11M/0.60M = e^{-k(54min)}$ k = 0.03142 min -1
    For 75% complete , A = (1-0.75)A_o = 0.25A_o
    $0.25A_o/A_o = 0.25 = e^{-.03142t}$ t = 44.1274 = 44 min
15. C and D increase, A B and E decrease
    $\Delta G = 0 = \Delta H - \Delta ST$
    ΔS = 133.6 J/K·mol = 0.1336 kJ /K mol
    $T = \Delta H/\Delta S$ (131.3 kJ/mol) / 0.1336 kJ /K mol = **982.8 K**